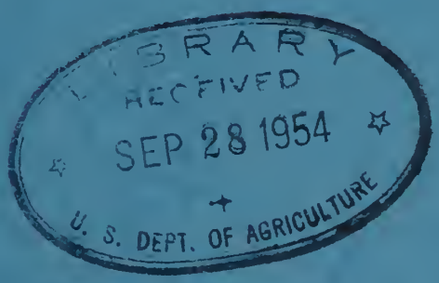
Annual Report



WESTERN SHEEP BREEDING LABORATORY

AND

UNITED STATES SHEEP EXPERIMENT STATION

DUBOIS, IDAHO

JUNE 30, 1944

This report of research projects not yet completed is intended for the use of administrative leaders and workers in this or related fields of research, and not for general distribution.

ANNUAL REPORT
Western Sheep Breeding Laboratory
and
U. S. Sheep Experiment Station
June 30, 1944

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H O N O R R O L L

Ensign L. Otis Emik,	H-V(S) N.N.M.C., Epidemiology Bethesda, Maryland.
Henry R. Keller A/S,	980-00-42, Co. 44-321 U.S.N.T.C. San Diego (33) California.
Elroy M. Pohle A/S,	795-06-07 Camp Bennion, Co. 733 Farragut, Idaho.
Lt. Chester F. Schaefer,	01846062, 471 Service Squadron, Army Air Field, Homestead, Florida.
Sgt. George M. Sidwell,	39828554, 137th Sta. Hospital, A.P.O. 709 c/o P.M. San Francisco, California.
Pvt. Lowell O. Wilson.	19136415, W.R R.S.D., Will Rogers Field Oklahoma City, Oklahoma

DIRECTORS OF STATE AGRICULTURAL EXPERIMENT STATIONS
OF THE TWELVE WESTERN STATES THAT ARE COLLABORATING
WITH THE WESTERN SHEEP BREEDING LABORATORY

ARIZONA:	P. S. Burgess, University of Arizona, Tucson.
CALIFORNIA:	C. B. Hutchison, University of California, Berkeley.
COLORADO:	H. J. Henney, Colorado State Agricultural College, Fort Collins.
IDAHO:	E. J. Iddings, University of Idaho, Moscow.
MONTANA:	Clyde McKee, Montana State College, Bozeman.
NEVADA:	S. B. Doten, University of Nevada, Reno.
NEW MEXICO:	Fabian Garcia, New Mexico State College of Agriculture, State College.
OREGON:	W. A. Schoenfeld, Oregon State College, Corvallis.
TEXAS:	A. B. Conner, Agricultural and Mechanical College of Texas, College Station.
UTAH:	R. H. Walker, Utah State Agricultural College, Logan.
WASHINGTON:	E. C. Johnson, Washington State College, Pullman.
WYOMING:	J. A. Hill, University of Wyoming, Laramie.

COLLABORATORS OF THE WESTERN SHEEP BREEDING LABORATORY

ARIZONA: Ernest B. Stanley, Head, Department of Animal Husbandry. College of Agriculture, University of Arizona, Tucson.

CALIFORNIA: James F. Wilson, Division of Animal Industry, College of Agriculture, University of California, Davis.

COLORADO: A. Lamar Esplin, Department of Animal Husbandry, Colorado State College of Agriculture and Mechanic Arts, Fort Collins.

IDAHO: C. W. Hickman, Head, Department of Animal Husbandry, College of Agriculture, University of Idaho, Moscow.

MONTANA: Richard T. Clark, Head, Department of Animal Husbandry, Montana State College, Bozeman.

NEVADA: Charles E. Fleming, Department of Range Management, College of Agriculture, University of Nevada, Reno.

NEW MEXICO: Philip E. Neale, Department of Animal Husbandry, New Mexico College of Agriculture and Mechanic Arts, State College.

OREGON: Ray G. Johnson, Head, Department of Animal Husbandry, Oregon State Agricultural College, Corvallis.

TEXAS: Bruce L. Warwick, Department of Animal Industry, Texas Agricultural Experiment Station, College Station.

UTAH: R. H. Walker, Director, Utah State Agricultural Experiment Station, Logan.

WASHINGTON: M. E. Ensminger, Head, Department of Animal Husbandry, State College of Washington, Pullman.

WYOMING: Fred S. Hultz, Head, Department of Animal Production, College of Agriculture, University of Wyoming, Laramie.

ROSTER OF PERSONNEL

WESTERN SHEEP BREEDING LABORATORY AND U. S. SHEEP EXPERIMENT STATION
Dubois, Idaho, as of June 30, 1944

Name	Rating	Date entered on duty	General Duties
Nordby, Julius E.,	Principal Animal Husbandman, P-6	Mar. 1, 1938	Director
Terrill, Dr. Clair E.,	Animal Husbandman P-4	July 3, 1936	Geneticist, Physiologist
Stoehr, John A.,	Animal Husbandman P-4	August 28, 1928	Operations
*Pohle, Elroy M.,	Animal Fiber Technologist, P-3	May 2, 1938	Wool Technologist
Hazel, Dr. Lanoy N.,	Animal Husbandman P-3	Sept. 1, 1942	Statistician
*Sidwell, George M.,	Animal Husbandman P-1	July 1, 1941	Assistant, Physiology and Genetics
*Emik, Dr. L. Otis.,	Animal Husbandman P-1	July 7, 1941	Assistant, Physiology and Genetics
*Keller, Henry R.,	Animal Husbandman P-2	Oct. 16, 1941	Assistant wool laboratory
*Schaefer, Chester F.,	Clerk, CAF-3	June 22, 1936	Clerk
**Harrison, Raymond H.,	Clerk, CAF-3	Oct. 25, 1937	Clerk
Taylor, Lois A.,	Clerk, CAF-3	April 17, 1944	Secretary
*Wilson, Lowell O.,	Scientific Aid SP-4	July 1, 1943	Assistant, Wool laboratory
***Lawson, Josephine M.,	Clerk-Typist CAF-2	June 5, 1944	Clerk-Typist
***McDonald, Judith L.,	Clerk-Typist CAF-2	June 16, 1944	Clerk-Typist
***Taylor, Jessie S.,	Clerk-Typist CAF-2	June 20, 1944	Clerk-Typist
***Beatty, Helen L,,	Statistical Clerk CAF-2	June 26, 1944	Statistical Clerk
Jeffery, Lee C.,	Foreman of Farm Laborers, CPC-6	June 7, 1924	General maintenance pumps, equipment
Rasmussen, Henry, Jr.	Farm Laborer CPC-4	July 1, 1926	Farm laborer
Hohman, Max E.,	Farm Laborer CPC-4	April 1, 1935	Shepherd
Landacre, Harold E.,	Farm Laborer CPC-4	April 6, 1939	Truck driver, general maintenance
Goldman, James R.,	Farm Laborer CPC-4	May 1, 1939	Shepherd
Waymire, Isom.,	Farm Laborer CPC-4	Sept. 21, 1943	Shepherd

ROSTER OF PERSONNEL (Con't)

Mattox, Dee H.,	Farm Laborer CPC-4	Nov.	3, 1943	Shepherd
Anderson, Daniel,	Farm Laborer CPC-4	Feb.	2, 1944	Shepherd
Phillips, Edward H.,	Farm Laborer CPC-4	April	19, 1944	Shepherd & Camp Tender
Walker, Raymond,	Farm Laborer CPC-4	April	6, 1944	Shepherd
Phillips, Walter H.,	Farm Laborer CPC-3	March	16, 1935	Truck Driver
Powell, Fred A.,	Farm Laborer CPC-3	May	11, 1935	Teamster
Hoopes, Wendell L.,	Farm Laborer CPC-3	April	16, 1941	Farm Laborer
Rawson, Thomas A.,	Farm Laborer CPC-3	March	23, 1942	Farm Laborer
***Young, William C.,	Farm Laborer CPC-2	May	17, 1944	Farm Laborer
Nantz, Dorinda R.,	Unskilled Laborer	June	16, 1941	Janitress & Cook

* On Military leave.

** Transferred to War Department, with re-employment benefits.

*** Temporary employees on three and six months War Service appointments.

F O R E W O R D

The basic design of the improvement program at this Laboratory does not afford a great deal of opportunity for major short-time advances in measurable progress because sheep reproduce rather slowly. The second generation is now in production. Moreover, the flocks involved are of relatively high productive capacity, under which condition improvement with any system of breeding would move somewhat slowly.

Changes in production occur from year to year. These are in a measure environmental, and may occur in such a manner that they obscure to some degree genetic changes from one generation to another. This would be particularly true if genetic progress were relatively slight.

Data have now been analyzed which afford a workably accurate estimate of the heritability of various useful characteristics. In the interpretation and application of the heritability of a character, there is still ample room for caution in drawing conclusions, and, for that reason, it is doubtful if the reader will discover many cases in this report where gains have been credited to genetic change unless there is fairly clear evidence available.

OBJECTIVE

The main objective of this laboratory is to improve sheep for lamb and wool production under range conditions. In the pursuit of this objective basic breeding methods are employed; heritability analyses are made of the various utility factors, and the selection of breeding animals is based upon production as that is measured under range environment. Emphasis is placed primarily on the quantity and quality of lambs produced; the length, quality and quantity of clean scoured wool, and upon the adaptability and longevity of the sheep.

SIGNIFICANCE OF THE PROBLEM

In the twelve western states there are 33 million sheep which produce annually 275 million pounds of wool, or 2/3 of the nation's annual production, and approximately 65 percent of the nation's annual lamb output. The bulk of this vast quantity of food and fiber supply is produced on millions of acres of western lands that cannot be used as successfully for other purposes. The problem is therefore to develop and improve range sheep so they can make the most efficient use of the crops of grass and brouse on these lands in converting them into the maximum amount of quality food and fiber. These vast areas of western lands will increase in value to the nation as we become more frugal in their use and more conscious of our ability to increase the potential efficiency of the sheep which graze upon them.

In general, this Laboratory has two distinct functions to accomplish. The first one of these is to improve the usefulness of the Rambouillet breed, which is the basic breed of the range sheep industry. The second job is to chart a course in the pursuit of the main objective so the methods involved can be resolved into a practical procedure available to the lamb and wool industry. Both of these are time consuming, but value to the industry need not await the ultimate in these efforts before it can definitely profit from the enterprise. Publications from this Laboratory, and from the U. S. Sheep Experiment Station which preceded it in Rambouillet improvement, have been numerous and date back almost a quarter of a century. For the most part these publications have been based upon actual records. In part they have been based upon philosophic innovations that were stimulated by what appeared to be reasonable deductions from existing records, and also upon a sincere desire to evaluate economic usefulness in sheep. Philosophic concept cannot always be anchored in basic records, because it must very often pioneer the way for the development of records, and the better the philosophy the more useful are the records.

The trusteeship with which the investigator is charged is deep-rooted. He must get at basic facts and interpret them in the light of advance as that is predicated upon fundamental economics of the industry involved. When the problem is one in breed improvement

it must mean basically just that. Constructive, creative, revitalizing germ plasm reorganization that provokes reenergized potentialities of enduring value must be the measure of improvement.

A quarter of a century is a relatively short time during which to expect a great deal of basic progress in breeds of livestock that reproduce as slowly as a sheep. This is particularly true when improvement efforts are applied to high producing flocks of a breed that is already generally efficient. Changes may come in a short period of time. In less than one-half of a century have occurred almost phenomenal changes in utility type in sheep in some areas. A conspicuous example of this is the whitefaced cross-breds of the western ranges. But this creation was not breed improvement, as that is generally understood. It was the product of breed admixtures and cannot be catalogued as breed improvement until the genetic gains have been consolidated into a uniformly functioning gene pattern. This, however, is in some flocks evolving into anticipated reality in the not too distant future.

Notable changes, that are often designated as breed improvement, may also occur in a breed within a given region. But this usually takes place by the introduction of superior breeding animals from outside sources, comprising the dissemination of germ plasm that already exists and cannot be clearly recognized as improvement of germ plasm in the breed. Moreover, when a breed comes into sudden popularity, it is generally noted that the average excellence of the individuals of that breed rises rather rapidly. But this apparent improvement is in very large measure due to the accelerated demand for breeding stock which has made improved feeding and management more profitable. While obviously all of these ways and means are of value to the industry, the investigator, if he has germ plasm improvement in mind for the breed, cannot allow these changes to confuse his approach to the solution he seeks.

Basic improvement in a breed is encumbent upon the progressive accumulation of desirable genes. When the gene pattern in a breed becomes generalized through heterosis, it is only very rarely that progressively noticeable gene accumulations occur. When they do occur the "accidental" sire or dam is a potential reality. Such "accidental" sires or dams are not the product of a planned design in gene pattern change. "Uncontrolled" heterosis is not fruitful of a uniformly occurring supply of these "accidents".

The high average production in the flocks of the western country is in considerable measure due to pronounced uncontrolled heterosis. It is obviously, therefore, not all bad. But, it is only a temporary expedient, and exploitive in its character. It is exploitive because we are merely temporarily recharging the gene potential for immediate gains without adequate regard for a planned reorganization of genetic gain and consolidation. There are some explanations for this situation. The economics of the sheep industry appears accelerative in its demand for immediate gains. In order to survive, the ranchman must comply. The breeder of range rams must comply. And, in many cases the breeder of stud rams does comply. Moreover, there has been no easily understood and readily applicable method available that has offered more immediate encouragement.

The general philosophy of improvement in sheep breeding is expressed in the slogan "breed the best to the best". And "best", in the absence of production records, has reference to the phenotype as it has been appraised in price or show ring competition. And surely this is not all bad. The original intent of the livestock exhibitions was to demonstrate animal form, the phenotype. And this they most assuredly accomplished. But as we became more "informed" in the "art" of animal breeding we permitted ourselves, probably through wishful thinking, to confuse the phenotype with genotype. This is permissable only to a limited degree in any stage of progress, and it decreases in value as the general phenotype standard increases above the average of the breed. Let us trust that the critic will be equally charitable in awaiting the reward of exploratory breeding methods now in progress, methods that seek the association of useful measurable values and the gene pattern.

Publications involving advantages to the ranchman of openfaced and smooth bodied sheep as compared with woolblind and wrinkled sheep have been released from this station for many years and have stimulated the general course of action in that direction throughout the entire west. They have also activated matters sufficiently so Rambouillets are now officially described as "free from body folds or wrinkles" and that the "eye area must be free from wool to insure good vision at all times". State experiment station investigators and writers share in the valuable contributions that have directed the thinking along constructive lines in the improvement of this important range breed.

Publications involving basic appraisals of general utility in sheep, utility qualities in wool production, and shrinkage information on range wool have been contributed to scientific and wool growers publications and to the general press, and these have already stimulated much concern and activity on the part of the commercial producer. In one of the western states in which commercial shrinkage estimates were lowered because of shrinkage studies, the growers profited over one million dollars in 1945. The State Experiment Station which actually carried the application of this research into the field deserves major credit for this accomplishment. It is cited here only to show that the pioneering research work is beginning to have its influence in the actual application of results in the field, and to show that the ultimate in the objective at this Station need not be reached before the industry can prosper by the effort.

There are now available two encouraging examples in sheep breeding of the application of gene pattern change that is designed to conform with usefulness. It has been clearly demonstrated by this time that the covered face and wrinkles in Rambouillet sheep are of no service to the breed, and that the open face and freeness from wrinkles have very definite economic value. Beachheads in the removal of these monstrosities have been established, and, while hazards still lurk in the path of progress, the line of march has been well outlined; the phenotypic change that has been made is the normal response of genic change; the interruptions are becoming fewer, and the horizon of progress is assuming a more encouraging aspect as the generations move along. These two characteristics are easily measured. Progress in

other body characteristics is not so easily appraised. It will require courage to deal with factual records, inhospitable as they may be. It will take directional stability to avoid tempting detours. And, finally, the charting of the course must be accomplished with clarity that is within the realm of practical reality.

In the pursuit of the above objectives the following studies are involved and are recognized as research lines:

RESEARCH LINE PROJECTS

1. Development of systems of breeding for locating strains of Rambouillet sheep which may possess combinations of genes that will improve strains with which they may be crossed. This research line project includes:

(a) The development of inbred strains or lines by the mating of animals as closely related as possible or desirable, and with emphasis on selection for all characters of economic importance.

(b) The development of inbred lines with special reference to very important characters that are of economic importance to range sheep, such as mutton form, length of staple, and faces that are free from excess wool covering causing wool blindness.

2. Determination of the inheritance of various undesirable characteristics of Rambouillet sheep, such as infective jaws, abnormalities in the growth of wool, hairiness in fleeces of wool and excessive skin folds or wrinkles, for the purpose of developing methods of breeding by which these undesirable characteristics may be eliminated from the stock.

3. Studies in the physiology of reproduction of Rambouillet sheep as they may contribute to the program of the Western Sheep Breeding Laboratory, including

(a) Sexual maturity of Rambouillet ram lambs.

(b) Quality of semen in relation to fertility, and

(c) Factors affecting fertility of ewes.

4. Studies in the physiology of wool production of Rambouillet sheep including reference to fiber uniformity within and between various regions of the fleece in relation to the total uniformity of the fleece.

5. Analysis of records of the characteristics of sheep and wool to determine the usefulness of such records in the program of the Western Sheep Breeding Laboratory.

PUBLICATIONS FOR 1944

(Previous publications are listed in the 1942 and 1943 annual reports).

30. Sampling and Measuring Methods for Determining Fineness and Uniformity in Wool. Circular 704, United States Department of Agriculture 1944, in press (This paper was listed but not assigned in the 1943 Annual Report), Elroy M. Pohle, L. N. Hazel, H. R. Keller.

35. Clean Wool Yields in Small Samples from Eight Body Regions as Related to Whole-fleece Yields in Four Breeds of Sheep. Elroy M. Pohle, L. N. Hazel, Journal of Animal Science V. 3., No. 2, 1944.

36. Shrinkage and Value by Grades for 1943 Range Wools. Elroy M. Pohle and H. R. Keller. Published in 1944 State Wool Growers Magazines and the National Wool Grower.

37. Some Factors Affecting the Blood Phosphorus level of Range Ewes. W. M. Beeson, Idaho Experiment Station, Clair E. Terrill, and D. W. Bolin, Idaho Experiment Station. Jour. of An. Sci. V. 3, No. 2, May, 1944.

38. Monthly Changes in Fineness, Variability and Medulation in Hairy Lambs. Elroy M. Pohle, H. R. Keller, L. N. Hazel. Submitted for Publication and approved for Jour. of An. Science.

39. More Profit in Open Face Ewes. Clair E. Terrill, Montana Wool Growers Magazine. Vol. 18, No. 1. January, 1944.

40. Variation and Size of Small Samples for Accurate Clean Wool Yield Determination. Elroy M. Pohle, L. N. Hazel, H. R. Keller. Submitted for publication June, 1944, directed toward Journal of Animal Science.

41. Percentage, Shrinkage and Value of Wool Off-sorts. Elroy M. Pohle, H. R. Keller. Wool Growers Publications, April, 1944.

A number of contributions have been made during the year to Livestock Journals and the general press that are not included in the series in the Annual Report. They are for the most part adaptations of the regular series, adapted for the lay reader.

SUMMARY OF RAMBOUILLET -- SPECIAL RESEARCH BREEDING
1943-44 Breeding Season

Pen No.	Ram No.	No. ewes	Type score	Yearling body weight (lbs.)	Yearling adj. fleece weight (lbs.)	Yearling adj. fleece length (cms.)	Inbreeding coefficient Dams (%)	Inbreeding coefficient Offspring (%)	Age of ewes at lambing (years)
18	619RW	25	2.36	79.32	8.43	6.10	17.55	22.79	3.68
19	487RW	28	2.27	83.93	8.68	6.00	16.56	20.53	4.32
20	944RW	25	2.35	82.72	8.61	6.10	10.20	12.98	4.24
21	578RW	23	2.26	85.50	8.79	6.76	8.19	11.06	3.65
22	2965W	30	2.42	86.13	9.56	6.21	9.54	11.24	3.70
23	45RW	23	2.23	84.43	8.67	5.75	10.60	15.03	5.09
24	903RW	31	2.33	86.00	8.59	6.18	13.97	19.02	3.87
25	2885W	30	2.26	87.33	8.71	6.14	2.00	9.28	4.03
26	6025W	30	2.21	92.93	9.89	6.01	2.08	2.98	5.23
27	556RW	24	2.29	87.46	8.92	5.97	10.87	17.15	4.46
28	3566W	29	2.29	92.14	9.49	5.73	2.62	8.48	4.86
29	466WP	29	2.31	90.90	9.67	5.96	0.25	8.62	4.90
32	542RW	33	2.34	84.88	8.98	5.98	9.18	18.62	4.24
34	926RW	26	2.20	86.96	8.59	6.18	11.00	17.75	4.12
35	4728W	36	2.27	93.69	8.49	5.78	3.99	3.58	3.83
36	4252W	29	2.29	90.38	8.73	6.07	0.97	8.20	3.93
37	3773R	31	2.07	87.35	9.30	6.21	2.29	19.32	4.35
39	3356W	30	2.46	85.30	8.90	5.97	2.50	8.02	4.77
40	3689W	31	2.27	93.74	8.97	6.01	2.92	7.74	4.06
40-	5326W	21	2.16	90.81	8.74	6.74	1.54	1.40	2.05
42	5368W	28	2.17	89.25	8.92	5.89	0.94	5.53	4.29
43	5666W	28	2.33	88.04	8.98	6.08	0.89	10.05	4.61
44	3409W	32	2.26	86.48	9.23	5.98	3.67	7.61	4.00
45	438WP	28	2.27	88.71	9.13	6.32	0.26	13.39	3.93
46	4622W	30	2.13	90.53	8.67	6.07	1.18	8.33	3.33
47	2219W	31	2.37	85.03	8.73	6.86	1.75	13.52	3.65
49	4932W	29	2.25	92.28	9.06	5.78	2.29	1.74	4.00
50	4664W	28	2.06	86.11	8.80	6.25	3.51	5.33	3.89
51	4185W	31	2.30	90.55	9.02	6.24	3.38	8.33	3.74
51-	4666W	20	2.18	83.75	8.23	6.47	9.11	5.18	2.40
53	5053W	30	2.21	86.43	9.11	6.30	0.00	5.83	3.87
54	4677W	29	2.21	89.07	8.89	6.50	2.23	2.83	3.55
AVE. FOR TOTAL		908	2.26	90.86	8.94	6.13	5.05	10.31	4.05

PROGRESS OF INBRED LINES

Matings were made in 30 inbred lines during the year 1943-44. No lines were added or dropped during the year. The number of ewes mated in the lines remained practically the same as the previous year. Two pens were included, in addition to the 30 line pens, in which covered face ewes from various lines were mated to open-faced rams.

Changes in inbreeding since the project was initiated are shown in the following table. There was an increase in the average percent of inbreeding for the offspring from 8.87 for 1943 to 10.31 for 1944. Furthermore, inbred offspring were born in every line for the first time this year. The average inbreeding coefficient for 1944 offspring was above 12.5 percent in 11 lines, ranging from 6.25 to 12.5 percent in 12 lines and was below 6.25 percent in 7 lines. The number of lines in the respective groups for 1943 was 7, 17 and 6. The proportion of inbred offspring increased from 60 percent in 1942 to 71 percent in 1943 and 81 percent in 1944.

		Inbreeding Coefficients in Percent			
Year Lambed	Potential Inbred Flocks	Ave. of Progeny	Increase Daughters over Dams	Highest for any Pen	Highest for any Individual
1938	20	3.92	2.83	13.30	37.9
1939	22	7.24	4.05	30.29	58.3
1940	34	8.25	4.70	32.58	58.3
1941	36	8.56	5.85	31.17	47.3
1942	37	8.62	4.67	28.71	39.9
1943	30	8.87	4.66	23.02	36.9
1944	30	10.31	5.26	22.79	48.0

The first 6 lines for each of the more important traits are listed in the following table for comparison with similar tables presented in previous years. These ranks are based on averages from weanling offspring in 1943.

	Rank of Line					
Trait	1st	2nd	3rd	4th	5th	6th
Body weight	42	43	28	29	36	40
Body type	29	45	42	51	26	54
Staple length	21	47	24	29	45	26
Open face	40	44	42	45	34	51
Freedom from folds	57	47	32	44	21	45

Only slightly more than half of the lines are included in the table. All of the lines except 3 were also included last year. The lines appearing 3 or more times are 29, 42, and 45. Again line 21 which was originally selected for length of staple excells for that trait as does line 40 for open face. Eleven lines (21, 24, 26, 29, 32, 34, 37, 40, 44, 47, 51) have ranked in the high 6 for one or more traits each of the last 3 years.

EFFECTS OF INBREEDING IN RAMBOUILLETS

A study of the effect of inbreeding on important traits with range sheep has been extended to include data from 2183 weanling lambs.

In weanling lambs, with each one percent increase in the inbreeding coefficient there was an average decrease of .29 pounds of body weight, .005 cm. of staple length, and a slight decrease in excellence of body type score. There was a slight increase in smoothness or freedom from folds and in covering of wool on the face with an increase in inbreeding. These changes are fairly consistent with those reported last year for yearling data with the exception of face covering.

HERITABILITY OF FLEECE AND BODY TRAITS OF RAMBOUILLET SHEEP

Estimates of heritability were presented last year based on daughter-dam comparisons with yearling ewes. Further determinations on 2183 weanling lambs have been based on half-sib correlations. These estimates are in general agreement with those obtained from daughter-dam regressions. Relatively high estimates of 67 and 45 percent were obtained for face covering and neck folds. Length of staple was 50 percent heritable. Weaning body weight was 35 percent heritable as compared with 40 percent for yearling body weight. As with yearlings a low figure (20 percent) was obtained for heritability of body type score. An even lower figure of 7 percent was found for condition score at weaning.

INCREASING THE ACCURACY OF SELECTION

The influence of sex, twinning, age of dam and age at weaning on weanling traits was studied on 2183 Rambouillet lambs born in 1941 and 1942. Most of the differences were highly significant although not all of them were large enough to be of practical importance. The percent of the total variance attributed to the above sources for the different traits were as follows: weaning body weight, 33; staple length, 16; body type, 15; condition, 9; neck folds, 8; and face covering, 5.

The differences in the various traits due to the above factors are listed in the following table:

Trait		Advantage of: Rams over ewes	Singles over twins	Older dams over 2 yr. dams	Ave. change per day at weaning
Body weight	(lbs.)	8.4	6.8	6.3	+.35
Staple length	(cm.)	—.47	.07	.18	+.01
Body type	(score)	—.39	.18	.16	+.01
Condition	(score)	—.06	.19	.16	+.01
Face covering	(score)	—.29	.02	—.09	0
Neck folds	(score)	—.12	—.27	—.25	—.01

The amount of change due to each factor was determined independently of the effects of the other factors.

The effects studied are largely environmental in origin and tend to obscure differences in genetic merit. The acquisition of more adequate seasonal grazing areas during recent years has made it possible to minimize the annual environmental influence thereby providing more uniform annual growth records. It is planned to adjust weanling traits for the most important differences, thereby increasing the accuracy of selections based on individual performance and on progeny tests.

PROGENY TESTING OF RAMBOUILLET, COLUMBIA, TARGHEE AND CORRIEDALE SHEEP

Summaries of the results of progeny tests were completed during the year on 193 sire progenies. Of these 65 were based on yearling offspring of rams used in lines, 41 on yearling offspring of rams used in test pens, 56 on weanling offspring of rams used in lines, and 31 on weanling offspring of rams used in test pens. The reduction in the number of rams tested was due both to a reduction in total numbers and to an increase in the number of ewes mated to each ram. Again emphasis was placed on body weight, mutton type, clean-fleece weight or grease-fleece weight, length of staple, face covering and skin folds.

A total of 56 rams were used in lines in the fall of 1943. Progeny tests had been made on 36 of these and 8 of the 20 untested rams were ram lambs. In addition 18 young rams were used in test pens of which 8 were ram lambs.

POLLED RAMBOUILLETS

Polled ram lambs and polled ewes (having depressions instead of horn knobs), all of which were sired by horned rams, were mated in the 2 polled lines in 1942. Forty eight lambs were weaned of which 12 were males with horns or females with horn knobs while 36 did not have horns or horn knobs. This supports Warwick's theory that horns in rams and horn knobs in ewes are due to one pair of recessive genes.

It may require from 6 to 8 generations to completely eliminate the horned gene from these lines. This may be shortened by 2 or 3 generations if homozygous polled males of sufficient merit to head the lines are produced and detected in the first and succeeding generations. Homozygous polled males will be detected by progeny testing polled rams with Rambouillet ewes having horn knobs. About 10 polled offspring to none having horns or horn knobs will be needed to prove beyond a reasonable doubt that the sire is homozygous for the polled trait.

REPRODUCTION CAPACITY OF RAMS AS INDICATED BY SEMEN TESTS

Semen tests were made on all breeding rams in 1943 in order to better insure high fertility in all breeding lines. A total of 468 ejaculates were examined from 140 rams. Of these rams 87 were used in breeding pens and 32 were not used because of poor quality semen. One ram of the 87 used proved to be sterile. Nearly all of the other 86 rams sired normal lamb crops.

Management of the rams was changed from that in 1942. Yearling rams were kept separate from the mature rams and were fed oats during the summer. The mature rams were fed oats for about 2 months prior to breeding. The quality of semen from yearling rams improved over that for 1942, but they were still inferior to the ram lambs. Mature rams produced considerably poorer semen in 1943 than in 1942.

Rams which were brought to station headquarters and fed oats and native meadow hay in a dry lot for about 2 months produced better semen than similar rams which were fed oats on pasture at the Modoc ranch. Further improvement in the feeding and management of the breeding rams will be attempted this year.

PRODUCTION INCREASED FOR RAMBOUILLET FLOCK

In any improvement program that is based on production records it is imperative that production performance of the individuals involved be in line with good management and the environment at hand. It is essential, too, for measuring the value of a breed, and in the application of progeny tests. The improvement in production noted in the accompanying table is encouraging.

Year	No. of lambs	Ave. weaning weight	Pounds of lamb per ewe bred	Percent of lambs weaned, based on ewes bred
1924-31	2313	71.2	51.4	72.2
1938	602	64.63	50.86	78.69
1939	588	64.56	46.20	71.60
1940	696	78.10	65.30	83.60
1941	768	76.43	65.70	85.90
1942	955	75.09	70.09	93.35
1943	827	79.60	76.40	91.60

These weights were made at about 135 days, when the ram lambs had to be removed from the flock, at which time weaning weights are taken on the ewe lambs also, and should not be confused with weights that are taken somewhat later when market lambs come off the range.

WOOL PRODUCTION FOR 1943 AND FOUR PRECEDING YEARS

Summaries of wool production for Rambouillet yearling ewes in 1943 and 4 preceding years, adjusted to 365 days growth are given in the following table.

Summary of Wool Production for 1943
and Four Preceding years for Yearling Rambouillet Ewes
(Adjusted to 365 Days Growth)

Years	1943	1942	1941	1940	1939
Fleece Characters	Mean	Mean	Mean	Mean	Mean
Fleece weight (grease) lbs.	8.05	7.89	9.34	9.12	8.94
Fleece weight (clean)					
* (Bone dry) lbs.	3.18**	3.52	3.40	3.10	2.79
*Commercial for breed	3.61	4.00	3.86	3.52	3.17
Clean Yield					
(Bone dry) %	39.87	44.61	36.43	33.97	31.24
*Commercial for breed	45.31	50.7	41.4	38.6	35.5
Staple length (cm.)	6.47	6.13	5.99	5.68	5.50
Staple length (inches)	2.55	2.41	2.36	2.24	2.17

* Corrected according to method advanced for side samples by Schott, Pohle, Spencer, and Brier (reference 23), and reported on commercial basis with a moisture content of 12%

** Estimated from nomograph by use of grease fleece weight and staple length.

The average grease fleece weight of 8.05 pounds was slightly higher in 1943 than in 1942 while the clean wool production of 3.61 was slightly less. The 1943 clean fleece weights were estimated from a nomograph by using grease fleece weight and staple length. This method is explained on page 23 of the 1943 annual report. The commercial clean yield in 1943 of 45.3 was about 4% lower than for 1942 but it was second highest for the 5 years involved. The Staple length of 2.55 inches was the longest in 1943. There has been a steady increase of .38 inches or about 1 centimeter from 1939 to 1943. Mean diameter and vaiability for 1939--1942 inclusive may be found on page 26 of the 1943 annual report but these same data are not complete yet for the 1943 fleeces.

LONG STAPLE LINE COMPARED WITH OTHER LINES

Pen 21 was designated as the long staple line of Rambouillets, and the offspring in this group have shown a steady increase in staple length each year over similar progeny for previous years.

Average of Yearling Progeny for Special Research Lines
(adjusted to 365 days growth)

Pen 21	Head	Staple length		Grease Fleece weight	Clean Fleece weight
(year)		(cms)	(inch)	(lbs.)	(lbs.)
1939	11	6.51	2.56	9.30	3.14
1940	16	6.78	2.67	9.55	3.81
1941	8	6.63	2.61	10.21	3.76
1942	7	7.21	2.84	8.05	3.98
1943	7	7.56	2.98	7.43	3.40
All others					
1939	303	5.50	2.17	8.94	2.76
1940	282	5.68	2.24	9.12	3.07
1941	290	5.99	2.36	9.34	3.45
1942	274	6.13	2.41	7.89	3.57
1943	277	6.47	2.55	8.05	3.18

The long staple line had 1.09 cm. greater length and .22 pounds more clean wool in 1943 than the average for all other Rambouillet progeny, while the grease fleece weight was .6 pound lighter. However, the clean fleece weight of pen 21 excelled all others by .22 lbs.

SHRINKAGE AND APPRAISAL VALUES ON GRADED, SORTED AND SCOURED CLIP FOR 1943.*

Grade		Staple length	Color and character	Shrinkage in percentage	Range of price on sorted and scoured basis	
					Main sort	Burry sort
EWES:						
Fine French Combing	64/70's	1½ - 2½"	Good	56.5	$ 1.24	$ 1.09
Fine Staple "	64's	2½" & longer	Good	51.3	1.26	1.18
Fine Yearling "	64's	2½" & longer	Choice	52.3	1.38	none
½ Blood "	60/64's	2½" & longer	Good	48.8	1.24	1.13
3/8 Blood "	56/58's	3" & longer	Choice	46.3	1.16	1.03
¼ Blood "	50/48's	4" & longer	Choice	43.0	1.06	.99
RAMS:						
Fine Staple Combing	64's	2½" & longer	Good	54.2	1.26	1.12
½ Blood "	60/64's	2½" & longer	Good	55.2	1.24	1.11
3/8 Blood "	56's	3½" & longer	Choice	51.6	1.14	1.06
¼ Blood "	50's	4" & longer	Choice	46.7	1.07	.99
PAINT SORTS:						
Fine & ½ Blood lots	60/64's	2½" & longer	Light paint	58.6	1.09	
3/8 & ¼ Blood lots	50/56's	4" & longer	Trace paint	54.2	1.01	
LOW & STAINED SORTS:						
Fine & ½ Blood	50's	Woolen	Stained, Burr, Tender	69.1	.91	
3/8 & ¼ Blood	46's	Under 3"	Stained, Burr, Tender	58.2	.90	
MISCELLANEOUS LOTS:						
Fine Crutchings	56/60's	Woolen	Stained & Defective	60.8	1.00	
X-Bred "	48's	Woolen	Tinged & Defective	53.4	.90	
Tags & Sweepings	56/50's	Woolen	Tinged & Defective	67.0	.95	

* As reported by Commercial Scouring Firm and CCC.

COMMERCIAL GRADING OF ENTIRE MATURE RAMBOUILLET EWE FLOCK (1943) *

The commercial grading and clean yield results for all fleeces from the entire flock of Rambouillet Mature ewes (test ewes included) for 1942 and 1943 show an increase for all economic factors for 1943 over 1942. That of greatest importance is the increase of nearly ½ pound of clean wool. The Fine Staple combing fleeces brought 87¢ more than the Fine French, while the ½ blood fleeces brought 40¢ more than the Fine Staple. This points out the importance of greater length of staple in fine-wool production.

Commercial Grading Results of Mature Rambouillet Ewe Flock (1943)*

	Fine Strictly Combing		Fine French Combing		½ Blood Combing		Average	
	1942	1943	1942	1943	1942	1943	1942	1943
% of total	29	57	69	39	2	4	100	100
Grease Fleece weight - lbs.	10.2	10.6	9.6	10.1	10.4	11.0	9.8	10.4
Commercial Clean Yield %	44.3	47.4	43.4	43.0	47.2	49.6	43.7	45.8
Clean Fleece weight - lbs.	4.52	5.02	4.16	4.35	4.91	5.45	4.28	4.76
Appraised Clean Value Boston for 1943 only.	--	1.17	--	1.15	--	1.15	--	1.16
Clean Fleece Value Boston	--	5.87	--	5.00	--	6.27	--	5.52

* The paint, low and stained sorts, crutchings and tags have been proportioned in all fleece weights and clean yields.

COMMERCIAL GRADING OF YEARLING AND MATURE RAMBOUILLET RAM FLEECES (1943)*

The following tables on Range Rambouillet Rams at this Station show the production of Fine Strictly Combing fleeces as compared with the Fine French Combing or shorter wool.

MATURE RAMBOUILLET RAM FLEECES

Grade	% of Total Fleece	Grease Fleece Weight (lbs.)	Commercial Clean Yield	Clean Fleece Weight (lbs.)	Appraised Clean Value Boston	Clean Fleece Value Boston
Fine Staple Combing	97	16.0	45.4	7.27	$ 1.16	$ 8.45
Fine French Combing	3	12.3	45.4	5.73	1.16	6.65
Average	100	15.8	45.4	7.16	1.16	8.31

YEARLING RAMBOUILLET RAM FLEECES

Fine Staple Combing	92	13.0	45.4	5.90	1.16	6.85
Fine French Combing	6	12.0	45.4	5 45	1.16	6.33
½ Blood Combing	2	14.8	45.4	6.72	1.12	7.53
Average	100	13.0	45.4	5.90	1.16	6.84

* The paint, low and stained and the burry sort are included in all data.

WOOL OFF-SORTS

In the range wool produced from Mature Rambouillet ewes in 1943 and processed by a commercial handler a number of off-sorts were made in accordance with commercial trade practice. The main sort constituted from 80 to 85% of the total in the fine grades of wool. The #1 Burry sort made up from 10 to 15% of the total lot and had depreciated value from 8 to 15 cents per clean pound due to the burs. The paint sort made up 4% of the total and the value was about 15 cents less than the main sort. The low and stained sort made up 1% of the total and this wool brought 34 cents less per pound than the main sort. There was ½ pound of crutchings removed from each ewe before shearing and this wool was valued at 25% less than the main sort. Tags and sweepings averaged 0.13 lb. per sheep and this wool had a decreased value of 30% per pound less than the main sort. Values for each grade of the various off-sorts are presented in the accompanying table.

RANGE IN PERCENTAGE, CLEAN YIELD AND GREASE VALUE OF OFF-SORTS IN 1943 CLIP *

Ewe Wool Grade Lot	No. 1 Main Sort			No. 1 Burry Sort			Paint Sort		
	%	Clean Yield %	Grease Value Boston	%	Clean Yield %	Grease Value Boston	%	Clean Yield %	Grease Value Boston
Fine French	85	46.6	$0.55	10	48.0	$0.49	4	41.4	$0.43
Fine Staple	79	49.2	.59	15	51.2	.57	4	41.4	.43
Yrlg. F. Sta.	90	47.4	.58	none	--	--	5	41.4	.43
1/2 Blood	89	50.7	.60	2	58.1	.62	5	41.4	.43
3/8 Blood	84	54.3	.50	7	55.9	.54	4	45.8	.44
1/4 Blood	84	58.1	.58	6	57.6	.54	4	45.8	.44

(Table continued)

	Low & Stained			Crutchings			Tags & Sweepings		
	%	Clean Yield %	Grease Value Boston	lbs. per Sheep	Clean Yield	Grease Value Boston	lbs. per Sheep	Clean Yield	Grease Value Boston
Fine French	0.7	30.9	$0.26	0.51	39.2	$0.37	0.13	33.0	$0.29
Fine Staple	0.9	30.9	.26	0.51	39.2	.37	0.13	33.0	.29
Yrlg. F. Sta.	5.0	30.9	.26	none	--	--	0.20	33.0	.29
1/2 Blood	3.0	30.9	.26	0.51	39.2	.37	0.16	33.0	.29
3/8 Blood	5.0	41.8	.35	0.51	46.6	.39	0.16	33.0	.29
1/4 Blood	6.0	41.8	.35	0.51	46.6	.39	0.16	33.0	.29

* All percentages and grease wool values have been rounded to the nearest whole number.

CLEAN WOOL YIELD DETERMINATIONS

A total of 227 wool samples and 10 half fleeces from 32 yearling Rambouillet ewes and from ram fleeces were scoured during the 1944 fiscal year. Percentage clean yield in the small side sample was used in determining the total amount of clean wool in each fleece.

With the adoption of the New Clean-Yield Method (as outlined on page 23 of the 1943 annual report) in 1943, it was necessary to scour only 30 samples from each breed of yearling ewes. The annual correction for variations in clean yield, based on 30 samples for each breed, and on annual variations in grease fleece weight and staple length were accomplished, thus saving much time in sampling, scouring and calculating. Clean fleece weights were estimated from a nomograph. This method was tested during this year by scouring small side samples from 113 yearling ewes. Actual results agreed very closely with those reported when the method was developed. Its use will be continued until it seems advisable to scour small samples from all yearling ewes again. The method is particularly useful for determining clean fleece weights on individual breeding animals and should not be used for determining shrinkage on large clips of wool.

WOOL QUALITY

A total of 2964 wool samples were taken from the Rambouillet yearling ewes and all rams, and determinations were made for fineness, uniformity and medullation. Samples were taken from (1) the middle of the shoulder, (2) middle of the back, and (3) over the hip bone from all rams but not from the Rambouillet yearling ewes, as suggested on page 24 of the 1943 annual report. It was found that by the blending of three samples a more representative appraisal of the fleece is accomplished. Of the total, only 380 samples were appraised which constituted the yearling and some mature rams.

THE INFLUENCE OF POSITION AND SIZE OF SAMPLE IN PREDICTING WHOLE-FLEECE CLEAN YIELDS.

A small sample of 35 grams of grease wool taken from the middle of the side or shoulder is adequate for estimating clean yield of the whole fleece. These findings resulted from a study of the fleeces of 40 ewes, wherein one-half of each fleece was scoured intact and the remaining half was scoured as 56 small samples. A clear trend of increasing accuracy from the margins of the body toward the middle of the side was evident. Samples weighing 100 to 200 gms. were slightly more accurate than those weighing 35 gms., but the difference was unimportant. (In process of publication.)

HAIRINESS IN LAMBS

Sixty-nine hairy lambs were selected at docking age, and monthly samples were examined to observe trends in fleece qualities until yearling age. In general, no important differences were found in the yearling fleeces of lambs that were or were not hairy at birth in regard to mean diameter, variability, or percentage medullation.

SOME MAJOR PROBLEMS IN BREEDING CROSSBRED SHEEP FOR WESTERN RANGE PRODUCTION *

The early history of the western range sheep industry is essentially one of fine-wool interests. Throughout the pioneering period of sheep husbandry in the west, emphasis was placed primarily on wool, and the interest in "mutton" was quite secondary to wool as a market product. Shortly after the turn of the last century, however, a demand was beginning to develop for the "lamb". Within a relatively short period of time, an industry that had been emphasizing wool over "mutton" was rapidly beginning to place "lamb" ahead of wool, particularly in the heavy feed-producing areas. The opportunity for the rugged, whitefaced crossbred ewe, with her high potential capacity for lamb and wool production, was definitely at hand.

The term "crossbred" when applied to range sheep has reference to the progeny resulting from the crossing of coarse-wool and fine-wool whitefaced breeds. These are commonly referred to as whitefaced crossbred, or, in the range country, merely as "crossbreds". The cross has, in general, been effected by breeding purebred coarse-wool rams of the Lincoln, Cotswold or Romney breeds to fine-wool range ewes, and also to purebred or near-purebred fine-wool ewes. The essential difference in the outcome of these crosses has varied somewhat in accordance with the size and type of sheep that were used in the original crosses and in the selections which have been made. The lambs produced from mating coarse-wool rams to ewes of Rambouillet breeding were more growthy, and developed into larger sheep than the progeny of coarse-wool rams and ewes of Merino breeding. There has also been some difference in wool grade objective among breeders.

The first cross ewes, commonly referred to as "straight" crossbreds have proved themselves excellently adapted to a number of areas where feed is relatively abundant, and many ranchmen regard them as the most profitable crossbred in those areas. They are large, comparatively smooth, openfaced and produce, in general, a fleece of good staple length that grades 3/8 and 1/4 Blood. Many of the fleeces are 3/8 - 1/4 Blood borderline fleeces. The straight crossbred ewes are, in the main, successful lamb producers. Moreover, the "cut" required to make commercial flocks of this cross relatively uniform in body and wool type is fairly small, varying from about 10 percent in the most carefully managed foundation flocks to 25 percent or above in those where less attention is paid to the selection of parental stock. The straight crossbred was also the least complicated to produce of all whiteface crossbreds. But, there were no rams of an established breed available for maintaining the characteristics of this cross. This type continued to be the result of the crossing of two breeds.

* It appears apropos to include this introduction to the report on crossbreds, inasmuch as the two reports are combined for the first time for the collaborating personnel. The major part of this introduction was published in the National Wool Grower in July and August 1943 and appeared in the U. S. Sheep Station Annual Report in 1943.

The population of crossbred ewes increased so rapidly that it appeared impossible, impractical or both to limit the requirement to straight crossbreds. Moreover, the straight crossbred did not appear to meet with universal acceptance, as many ranchmen preferred to operate with crossbreds that had a larger percentage of fine-wool breeding than the straight crossbred carried. This was not necessarily a matter of arbitrary choice, but rather an effort to produce crossbred ewes that were more suitable to less productive range areas than were those where the straight crossbred ewe was at her best. This appeared possible by increasing the percentage of fine-wool influence and thus insuring more hardiness and a relatively "tight" fleece that would not "brush". The only means available of increasing the fine-wool influence was to breed the first cross ewes back to fine-wool rams. But, there was no breed of sheep available that produced rams for maintaining the characteristics of this second cross. Hence, in order to make use of the progeny of first cross ewes and fine-wool rams as flock replacement ewes, the only choice was to breed them to fine-wool rams or coarse wool rams, and the respective progenies of these two crosses were very different. The problems which faced the ranchman in producing replacement ewes from the first cross ewe gave rise to some very active exploratory practices in crossbreeding that were subsequently characterized by more or less confusion which left much to be desired in flock type stability.

The backcrossing method involved the breeding of fine-wool rams to first cross ewes. This cross produced the three-quarter fine-wool-one-quarter coarse-wool cross commonly known as the "comeback". The typical comeback is a little smaller than the straight crossbred and produces, in general, 1/2 Blood wool. It is also somewhat more hardy and has a little longer productive life than the straight crossbred. The comeback ewes fit into many areas where feed is not plentiful enough for optimum production by the straight crossbred. Since there were no three-quarter rams available, however, comeback replacement ewes could be produced only by mating the fine-wool rams to the first-cross ewes, thus requiring two sheep generations for the production of the comeback.

While the whitefaced crossbred sheep industry of the West was very enterprising in the magnitude it assumed and methods it used, it was unique in so far as it overlooked somewhat the inevitable need for paralleling the development of crossbred ewes with an adequate supply of suitable crossbred rams. It was rather natural that this would happen since there was little crystalized understanding with reference to just what characteristics a crossbred ram should have in body and wool type. Moreover, differences in environmental conditions did not make all areas equally suitable for one type of crossbred. Furthermore, trading in wool was on the "original bag" basis with major emphasis on estimated shrinkage values and with little concern for graded contents, as they may have influenced price differentials. Market requirements at country points were relatively easy to satisfy, except for shrinkage, hence there was very little economic disoipline to guide the producer in his choice of grade, and very little encouragement to package a graded, quality product.

The natural result of this definite lack of recognition for intrinsic value in the wool clip did not offer adequate compensation for improving the flocks, nor did it serve as adequate penalty against the further admixtures of breeding. The consequence was not only the rather free use of back-crossing to rams of the foundation breeds, but the use of first and second cross rams, and also rams with almost any combination of whitefaced breeding that it is possible to produce through interbreed and intergrade crossing.

As a result of the admixture of breeding in western whiteface crossbreds it is often necessary, in the production of replacement ewes, to cut back 20 to 30 percent of the ewe lambs as feeders in order to have a fairly uniform band of prospective yearlings. When these are yearlings, often another cut of 10 to 20 percent should be made. If no culling is done before the yearling age, often the cut runs from 30 to 50 percent before a fair degree of uniformity is realized in wool and body type.

The scrambled admixture of parent breeds in the general population of crossbreds is by no means all wrong. Production records prove abundantly that the western whitefaced crossbred sheep are generally very productive of lambs and wool. Even though the methods used in crossing have had no particular design in their aim for maximum production, the crossbreeding that has been done, in the absence of a well-defined method, has been generally fruitful in bringing about a stimulating effect in production under the conditions at hand. There is perhaps no other example of crossbreeding in the annals of livestock husbandry which has been so fruitful of increased total production for the purpose desired.

This extensive admixture of breeding, however, which involved two foundation breeds that were very different in wool and body type, has been equally as productive of variability in body and wool types as it has been stimulating to high total production. Therefore, two well-defined jobs lie ahead. One of these is the matter of maintaining the degree of production that has come about through crossbreeding, --or even exceeding it. And the other job is to narrow down the variations in both body and wool types, and thus stabilize in grade of product so the lambs and the wool are made greatly more uniform than they now are within flocks, within areas, and within the population as a whole.

To accomplish these two jobs this Station has under way a well-organized breeding program involving the production of a substantial number of inbred lines. The fundamental elements of inheritance present that govern high production and prepotency will have opportunity to properly combine when these inbred lines are judiciously crossed. Ewes and rams are rigidly selected from production records, for quality as well as for quantity production, as these are determined by measurable characteristics of practical value. The rams are progeny tested before they are used in a main line. If they pass a breeding test successfully they are used in a main line and become designated as stud rams if they prove worthy of that designation when bred to ewes in a main line.

Considerable courage has been displayed by breeders who have expressed their idea of what constitues practical merit in crossbred rams by developing crossbred breeds. Among the breeds and strains now available for crossbred ram production are the Corriedales (originating in New Zealand), the Columbia, Panama, Romneldale and Targhee (originating in the United States). The comparatively few flocks involved have already been of considerable service, as their influence has been felt in pointing the way to the stabilizing of body and wool type. But much has yet to be done! The ranchman will be asking where he can procure an adequate supply of crossbred rams that are well enough bred and carefully enough selected so he can rely upon them for effecting the desired improvement. The breeders of such rams must eventually answer this question. It cannot be answered by the indescriminate use of first-cross rams, nor by back-crossing to the parent breeds.

In an effort to contribute to the solution of the rather complex problems that confront the producers of crossbred sheep, the Bureau of Animal Industry undertook, some thirty years ago, the task of getting fundamental information pertaining to their production, as that might become available through the actual development of crossbreds suitable for range production. This work was done very largely at the U. S. Sheep Experiment Station, Dubois, Idaho, and undertaken in the spirit of orderly investigation and inquiring purpose. The investigations were made under range conditions where the actual year around range problems had to be faced. The first effort that was undertaken culminated in the development of the Columbia breed. An additional effort, somewhat different in nature, has given rise to the Targhee.

The Columbia is, in general, the result of breeding select Lincoln rams to Rambouillet ewes, and proceeding from this step by mating the most select first-cross rams to carefully selected first-cross ewes, and then interbreeding the most select rams and ewes descending from them. The essential objects were to determine if and also how the commendable qualities of the Lincoln-Rambouillet crossbred could be stabilized into a useful range breed. There were two general methods available that offered possibilities. Either cull lightly and increase numbers rapidly, or cull heavily and accumulate numbers more slowly. The latter was selected as the more basically sound approach from the experimental point of view, as doubtless it would yield maximum progress in stabilizing wool and body type. Throughout the development of the breed, selection has constantly been based on total production of wool and lamb, as that influences the economics of range sheep husbandry.

The foundation of the Targhee was laid by the use of Corriedale, Lincoln, and Rambouillet rams and Corriedale and Rambouillet ewes. Two basic combinations were made. Rambouillet rams were bred to Lincoln-Rambouillet first-cross ewes. And Rambouillet rams were also bred to ewes that were produced by mating Corriedale rams to Lincoln-Rambouillet first-cross ewes. Rams and ewes from these two combinations of breeding were carefully selected and interbred, and later developed into the Targhee.

The results that have been accomplished in stabilizing the grade of wool in the Targhee should prove encouraging to the ranchman who is interested in producing 1/2 Blood wool. In 1942 the Targhee ewe fleeces were graded 94 percent 1/2 Blood and 6 percent 3/8 Blood. The ram fleeces were graded 99 percent 1/2 Blood and 1 percent 3/8 Blood.

In 1941 and 1942 about three percent of the ewe lambs were culled for fleece irregularities such as shaggy breech, short staple, hairy fleece, wool blindness and for other wool characteristics that were below the standard for stud ewes. Thirteen percent were culled because they were below the required standards for stud ewes in body type. Small size, a low topline, small bone, steepness in the rump, and wrinkles in the skin about the neck or body constituted the main reasons for culling. Not all animals in breeds that have been established even for a long time meet stud requirements.

There is a very definite need for a well-organized effort to improve the type of wool and body conformation in whitefaced crossbred range sheep. That this can be done appears evident from the production records of the Columbias and Targhees which show that very substantial progress has been made in producing stability of wool and body type in two lines of cross breeding, both of which originated from admixtures of two or more breeds that were substantially different in wool and body type. The records also show that this has been accomplished under range conditions by pursuing a well-defined objective in an orderly manner, and, briefly herein lies the solution for stabilizing the grade of wool and the body type of the whitefaced crossbred sheep of the West.

SUMMARY OF EWES IN COLUMBIA BREEDING PENS
1943-44 Breeding Season

Pen No.	Ram No.	Kind of Mating	No. of Head	Type Score	Yearling Body Wt. (lbs.)	Yearling Adj. Fleece (wt.)	Yearling Adj. Fleece (cms.)	Inbreeding coefficient Dams	Inbreeding coefficient Offs.	Age of Ewes at lambing (years)
								%	%	
1	3477K	Line	22	2.00	99.55	10.32	9.4	6.11	14.82	3.64
		Line crosses	30	1.90	100.2	9.52	9.44	3.80	8.45	3.13
1	3264K	Line	20	1.95	101.0	10.31	9.66	4.67	16.71	3.5
		Line crosses	31	2.01	98.1	9.80	9.06	2.56	9.78	3.65
2	3719K	Line	26	1.96	99.69	10.00	9.52	8.86	13.01	3.69
3	3734K	Line	26	1.85	101.31	10.73	8.98	2.36	14.55	3.50
4	3546K	Line	27	2.14	96.67	9.89	9.89	5.10	10.63	2.74
5	3435K	Line	24	1.97	99.83	9.46	9.04	6.20	13.09	3.29
		Line crosses	30	1.82	100.5	10.46	9.69	6.38	8.06	2.93
5	4009K	Line	20	1.97	96.2	9.28	8.89	3.38	9.39	3.45
		Line crosses	29	1.93	103.93	10.68	9.11	4.45	2.49	3.76
6	3522K	Line	20	1.95	99.35	9.79	8.98	7.33	13.26	3.60
7	4265	Line	28	1.93	99.04	10.31	8.41	5.61	9.08	4.79
8	4061K	Line	20	2.00	94.35	9.89	8.74	2.67	8.31	3.90
9	4444K	Line	31	1.92	98.03	10.11	8.89	5.21	8.54	3.77
10	4528K	Line	35	2.07	96.6	10.14	8.44	2.91	4.17	4.63
Average for line pens			419	1.96	99.10	10.06	9.10	4.79	9.74	3.66
11	4263K	Test	31	1.93	95.9	10.08	8.96	0	1.48	4.90
12	4084K	Test	32	1.93	97.69	10.02	9.26	0	1.49	5.00
13	3965K	Test	30	2.22	94.8	9.92	9.09	0	2.0	5.13
14	4171K	Test	34	1.98	98.5	10.37	8.97	0	1.56	5.06
Average for test pens			127	2.01	96.28	10.11	9.07	0	1.71	5.01
Average for ALL			546	1.97	98.44	10.07	9.09	3.67	7.86	3.97

PROGRESS IN DEVELOPING LINES OF COLUMBIA SHEEP

Matings of Columbias were continued in 10 lines and 4 test pens in the fall of 1943. The total number of ewes bred increased from 510 in 1942 to 546 1943. Some data on the various lines and test pens are listed in the accompanying table.

The average inbreeding coefficient for all Columbia dams increased from 3.15 percent in 1942-1943 to 3.67 percent in 1943-1944. However the average inbreeding for all offspring decreased from 8.80 percent in 1943 to 7.86 percent in 1944. This decrease was chiefly due to the changing of rams in all lines but one and to initiating a program of line crossing which is described later. The average increase in inbreeding for offspring over dams this year was 4.19 percent.

LINE CROSSES IN COLUMBIAS

A program of crossing Columbia lines was initiated in the fall of 1943. The objects were to explore the possibilities of line crosses and the crossing value of the lines. This program appeared desirable in order to establish the earliest possible date following the formation of lines at which the heterosis expected for line crosses might be of economic importance and at which their future value for crossing might be appraised. In addition, this program will furnish information about the breeding values of sires and lines which will aid in the further development of the inbred lines. The surplus cross-line progeny will be sold as stud breeding stock.

A design for line crossing was developed which would provide maximum information and which was adapted to the number of sheep and facilities available for this work. Two sire lines (1 and 5) were selected for crossing with each other and with 4 other lines (3, 4, 6 and 8). Each of two rams from lines 1 and 5 were mated with ewes from those lines and with ewes from 2 of the other 4 lines. Ewes from the various lines were sorted out by the use of random numbers. This design will furnish estimates of the following:

(1) differences between the crossing values of lines 1 and 5.

(2) differences between sires within lines 1 and 5.

(3) differences between the crossing values of lines 1, 5, 3, 4, 6 and 8 as female lines.

(4) differences within lines and crosses.

Results for the straight-line and cross-line progeny for birth weight only are shown in the following table. The cross-line offspring exceeded the straight-line offspring by 0.51 pounds in birth weight. Sire differences were apparent within both lines 1 and 5. These differences which amount to about 5 percent of the mean appear surprisingly large in view of the fact that inbreeding of the straight-line offspring exceeded that of the cross-line progeny from only 6 to 7 percent.

Averages and Differences in Birth Weights (lbs.) from Straight-Line and Cross-Line Progeny in Lines 1 and 5.

Line	Sire	Straight line	Cross line	Difference
1	3477K	10.30	11.04	0.74
	3264K	9.32	9.59	.27
	Average	9.78	10.29	.51
	Difference	0.98	1.45	----
5.	3435K	10.71	11.13	.42
	4009K	9.24	9.66	.42
	Average	9.84	10.35	.51
	Difference	1.47	1.47	----

PROGRESS IN DEVELOPING LINES OF TARGHEE SHEEP

Targhees were bred in 8 lines and 1 test pen (pen 9) in the fall of 1943 as shown in the accompanying table. The number of ewes involved increased from 225 in 1942 to 252 in 1943. The average increase of inbreeding for the offspring over their dams was 7.2 percent which again was highest for any of the 4 breeds. The average inbreeding remained about the same as last year for both the offspring and their dams.

Efforts to increase the numbers of Targhees were accelerated last fall. The number of additional ewes placed in Targhee breeding increased from 88 in 1942 to 325 in 1943. Rambouillet ewes were mated to both Targhee and Columbia rams. The offspring will be top-crossed with Targhee rams one or more times before introducing the descendants into the Targhee flock. This plan will permit comparisons of straight Rambouillets with Targhee--Rambouillet and Columbia--Rambouillet crosses. A few Lincoln--Rambouillet ewes were mated with Rambouillet rams to produce first cross Targhee offspring.

PROGRESS IN DEVELOPING LINES OF CORRIEDALE SHEEP

Corriedale matings were continued in 4 lines in 1943-1944 as listed in the accompanying table. The average percent of inbreeding increased from 4.17 to 4.63 for the dams and from 8.94 to 9.95 for the offspring for 1944 over 1943. The average increase in inbreeding for the offspring over the dams for 1944 was 5.3 percent. The average age of the ewes bred increased from 3.9 years in 1943 to 4.5 years in 1944. This indicates a marked increase in the intensity of selection of the younger ewes.

SUMMARY OF EWES IN TARGHEE BREEDING PENS
1943-44 Breeding Season

Pen No.	Ram No.	No. Ewes	Type Score	Yearling Body Wt. (lbs.)	Yearling Adj. Fleece Weight (lbs.)	Yearling Adj. Fleece Length (cms.)	Inbreeding coefficient Dam (%)	Inbreeding coefficient Offs. (%)	Age of Ewes at lambing (years)
1	1587T	25	1.93	92.08	9.19	7.19	7.78	15.68	4.40
2	1828T	30	1.94	86.63	8.80	8.08	7.71	14.41	3.57
3	2442T	25	2.07	89.36	9.00	7.44	3.84	6.88	3.56
4	1807T	32	2.01	89.97	9.18	7.72	0	11.81	3.59
5	1492T	30	2.08	88.83	9.27	7.62	4.64	8.83	4.47
6	2445T	28	1.95	91.43	9.60	8.40	0.93	10.06	3.68
7	2434T	25	2.09	88.32	9.52	7.60	8.19	15.98	4.48
8	2068T	28	2.11	89.46	9.82	7.70	3.94	6.60	4.54
9	2311T	29	2.00	88.21	8.88	8.48	0.43	2.48	2.79
Average for ALL		252	2.02	89.33	9.28	7.82	3.03	10.23	3.89

SUMMARY OF EWES IN CORRIEDALE BREEDING PENS
1943-44 Breeding Season

1	3959A	26	2.28	88.04	9.43	8.92	4.62	11.50	4.62
3	3666A	25	2.37	84.12	9.56	9.95	4.85	8.40	4.24
4	4015A	28	2.40	82.82	9.52	9.05	5.27	13.48	4.43
5	3964A	26	2.26	84.58	8.61	9.20	3.76	6.09	4.58
Average for ALL		105	2.33	84.85	9.28	9.27	4.63	9.95	4.47

ELIMINATION OF HORNS AND SCURS IN COLUMBIA AND TARGHEE SHEEP

An investigation of the occurrence of horns and scurs in the male and horn knobs in the female for the Columbia and Targhee breeds has been made beginning with sheep on hand and including lambs born since 1937.

In the Columbias data are available on 2484 weanling lambs. About 4 percent of the ram lambs had horns, 35 percent had scurs and 61 percent were polled. About 4 percent of the ewe lambs had horn knobs and 96 percent were polled.

In the Targhees data are available on 1300 weanling lambs. About 8 percent of the rams had horns, 62 percent had scurs and 30 percent were polled. About 7 percent of the ewe lambs had horn knobs and 93 percent were polled.

In both breeds some polled rams produced horned offspring and some rams with scurs produced no horned offspring. Rams with scurs produced more offspring with scurs and horns or horn knobs than did polled rams. Studies are being continued to determine the significance of scurs as related to the inheritance of polledness.

CLEAN WOOL YIELD DETERMINATIONS

A total of 797 wool samples and 10 half-fleeces were scoured from the Targhee, Corriedale and Columbia yearling ewes during the 1944 fiscal year. Percentage clean yield derived from 30 samples from each breed, representing each of the three breeds was used in determining the correction factor for variation in clean yield.

WOOL QUALITY MEASURED

A total of 1732 wool samples were taken from the Targhee, Corriedale, and Columbia yearling ewes and from all rams for fineness, uniformity and medullation determinations. All samples from yearling rams were completed.

Summary of Wool Characters for 1943 and Four Preceding Years
Yearling Ewes by Breed
(Adjusted to 365 days growth)

TARGHEE

Years	1943	1942	1941	1940	1939
	Mean	Mean	Mean	Mean	Mean
Fleece Characters					
Fleece weight (grease) lbs.	8.15	7.96	9.39	9.92	9.44
Fleece weight (clean)					
* (Bone dry) lbs.	3.50**	3.81	3.59	3.72	3.19
* Commercial for breed	3.98	4.33	4.08	4.23	3.63
Clean yield					
* (Bone dry) %	43.10	47.92	38.19	37.53	33.87
* Commercial for breed	48.98	54.45	43.40	42.65	38.49
Staple length (cm.)	8.11	8.10	7.50	7.00	6.61
Staple length (inches)	3.19	3.19	2.95	2.75	2.61

CORRIEDALE

Fleece weight (grease) lbs.	8.54	7.88	9.53	9.38	9.51
Fleece weight (clean)					
* (Bone dry) lbs.	3.86**	3.93	4.01	3.81	3.67
* Commercial for breed	4.39	4.47	4.56	4.33	4.17
Clean yield					
* (Bone dry) %	44.03	49.90	42.07	40.66	38.56
* Commercial for breed	50.03	56.70	47.81	46.20	43.82
Staple length (cm.)	9.85	10.10	8.98	8.36	8.49
Staple length (inches)	3.88	3.98	3.54	3.29	3.34

COLUMBIA

Fleece weight (grease) lbs.	9.06	8.87	10.67	11.39	9.88
Fleece weight (clean)					
* (Bone dry) lbs.	3.94**	4.13	4.10	4.22	3.78
* Commercial for breed	4.48	4.69	4.66	4.80	4.29
Clean yield					
* (Bone dry) %	43.29	46.51	38.46	37.05	38.21
* Commercial for breed	49.19	52.85	43.70	42.10	43.42
Staple length (cm.)	9.48	9.53	8.29	8.33	7.87
Staple length (inches)	3.73	3.75	3.26	3.28	3.10

* Corrected according to method advanced for side samples by Schott, Pohle, Spencer, and Brier (reference 23), and reported on commercial basis with a moisture content of 12%.

** Estimated from nomograph by use of grease fleece weight and staple length.

WOOL PRODUCTION BY GRADE AND BREED
BASED ON COMMERCIAL RESULTS*

Grade	YEARLINGS				MATURE			
	Number of Fleeces	% of Total	Grease Fleece Weight	Clean Fleece Weight	Number of Fleeces	% of Total	Grease Fleece Weight	Clean Fleece Weight
RAMBOUILLET								
Fine French Combing	28	6	7.50	3.24	614	39	9.98	4.31
Fine Staple Combing	405	88	8.76	4.06	895	57	10.42	4.95
1/2 Blood	28	6	9.25	4.62	50	3	10.91	5.43
Average	461	100	8.71	4.04	1559	99	10.26	4.60
TARGHEE								
Fine Staple Combing	2	2	7.17	3.59	23	10	9.14	4.34
1/2 Blood	77	83	8.93	4.46	179	80	9.82	4.89
3/8 Blood	14	15	9.25	4.88	21	10	11.15	5.87
Average	93	100	8.95	4.51	223	100	9.87	4.92
CORRIEDALE								
1/2 Blood					28	22	9.36	4.66
3/8 Blood	15	79	9.22	4.87	91	71	9.95	5.23
1/4 Blood	4	21	10.00	5.57	9	7	11.64	6.45
Average	19	100	9.38	5.01	128	100	9.94	5.19
COLUMBIA								
1/2 Blood	5	3	9.95	4.97	18	4	9.67	4.81
3/8 Blood	110	62	9.88	5.22	296	58	10.77	5.66
1/4 Blood	63	35	10.38	5.78	196	38	11.85	6.57
Average	178	100	10.06	5.41	510	100	11.15	5.98

* All weights include crutchings but not tags. The yearling ewes were not crutched in 1943.